“Sleep Runs in 90-Minute Cycles” Is True, and Says Nothing

— the fractions lost are **0.157609** against **0.700000**, so REM is lost **4.441379** times as heavily — the separator is whether one looks at the cycle or at the division within it — [Paper 694]

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— From thinking to syncing. —

Abstract

Sleep is said to run in ninety-minute cycles. The cycle is indeed constant, and its very constancy is what hides the change inside it.What is lost, and how unevenly, when a night is cut short is counted here from the division.No new theorem or law is claimed. First, and this is the core. The length is constant while the contents exchange places——0.760870 of the deep sleep falls in the first two cycles and 0.600000 of the REM in the last two (Section 2). **Second, the two move monotonically in opposite directions——deep sleep runs 40, 30, 15, 5, 2 minutes and REM runs 10, 15, 25, 35, 40** (Section 2). **Third, so cutting the night short loses unevenly——cut in half it leaves 0.842391 of the deep sleep and only 0.300000 of the REM** (Section 3). **Fourth, the unevenness exceeds a factor of four——the fractions lost are 0.157609 against 0.700000, so REM is lost 4.441379 times as heavily** (Section 3). **Fifth, the last quarter still carries REM——after three quarters of the night deep sleep has reached 0.964674 while REM stands at 0.610000** (Section 3). **Sixth, the separator is whether one looks at the cycle or at the division——a constant length divides nothing, while a monotone division makes the point of cutting decide what is lost** (Section 4). **Keywords**: sleep cycle, slow-wave sleep, REM sleep, uneven division, shortened sleep, cycle against content.

Scope of this paper (scope note): No new theorem or law is claimed——that the sleep cycle runs about ninety minutes, and that slow-wave sleep is concentrated early and REM late, are both standard (Kryger et al. 2017, Borbely 1982).Physiology is not treated——the generation of slow waves, the role of REM and the contents of the two-process model are not treated.The fractions are not claimed——the minutes per cycle are representative and move with person, age and the state of the day; five cycles over seven and a half hours are assumed.Health effects are not discussed——the consequences of short sleep, effects on memory and how much sleep is needed are not the subject.Scoring is not treated——the criteria by which sleep stages are scored from the electroencephalogram are not treated.Relation to earlier papers: Paper 684 showed that the Sun does not have two periods, and that 22 years vanished and 11 remained because the sign was thrown away before counting——there the value of the “period” itself changed with the counting. Here the value is settled and the contents exchange places instead. The same word fails in two different ways.What is added is setting out the minutes per cycle and showing the two to move monotonically in opposite directions, contrasting **0.842391** with 0.300000 at half the night, putting the ratio of fractions lost at **4.441379**, showing REM to stand at **0.610000** even after three quarters, and placing the separator on cycle against division.

1. Notation and the Question

Setting: take a night as five cycles of equal length (90 minutes each, seven and a half hours in all) and assign representative minutes of deep and REM sleep to each.

$$T_{\text{cycle}} = 90 \text{ minutes (constant)}, \qquad G(f) = \frac{\sum_{\text{first } f} x_i}{\sum_i x_i}$$

$G(f)$ is the fraction obtained on sleeping a fraction f of the night from its start, a partial cycle counting pro rata.

Question: when one says “the cycle is ninety minutes”, what has been said and what has not?

2. Constant Length, Exchanging Contents

Computation 2.1: the minutes per cycle were assigned.

cycle	deep sleep	REM sleep
first	40.0 min	10.0 min
second	30.0 min	15.0 min
third	15.0 min	25.0 min
fourth	5.0 min	35.0 min
fifth	2.0 min	40.0 min
total	92.0 min	125.0 min

0.760870 of the deep sleep falls in the first two cycles and 0.600000 of the REM in the last two.

> **Observation 2.2**
>
> **this is the core: a constant length divides nothing.Every cycle is ninety minutes, and to an eye on duration alone the same thing happens five times——yet the contents move monotonically, and the two of them in opposite directions.**

> **Observation 2.3**
>
> **“there is a cycle” is commonly heard as “it repeats”.What repeats is only the length; the content never repeats once——the word invites constancy of duration to be mistaken for constancy of content.**

3. Where One Cuts Decides What Is Lost

Computation 3.1: the fraction obtained on sleeping a fraction of the night from its start was derived.

slept	deep sleep	REM sleep
half (four hours)	0.842391	0.300000
three quarters (six hours)	0.964674	0.610000
all (seven and a half hours)	1.000000	1.000000

Observation 3.2

halving the night does not halve both.The fractions lost are 0.157609 for deep sleep and 0.700000 for REM, a ratio of 4.441379——the sentence “sleep was cut in half” does not say what was cut in half.

Observation 3.3

the last quarter hardly concerns deep sleep.By three quarters of the night deep sleep has reached 0.964674 ——the same “another hour and a half” is nearly meaningless for one and worth 0.390000 to the other.

Observation 3.4

so hours slept does not stand for the two quantities equally well.For deep sleep a short night nearly suffices; for REM nothing short of the whole night does——one measure never represents two quantities to the same accuracy.

4. The Separator

Observation 4.1

the separator is whether one looks at the cycle or at the division within it.A constant length divides nothing, while a monotone division makes the point of cutting decide what is lost——unless the quantity that is changing is looked at, nothing has been said.

Observation 4.2

beside Paper 684.Paper 684 showed that the Sun does not have two periods, 22 years vanishing and 11 remaining because the sign was thrown away before counting——there the value of the “period” changed with the counting; here the value is settled and the contents exchange places. The word fails in more than one way.

Observation 4.3

what is not said.Physiology, health effects and scoring are not treated, and every fraction is representative——what is shown is that a constant cycle can hide a monotone change inside it.

5. Roll Call and Closing

1. **0.760870 of deep sleep in the first two** (Computation 2.1): **the core.**
2. **0.600000 of REM in the last two** (Computation 2.1): **the opposite direction.**
3. **deep sleep from 40 to 2 minutes** (Computation 2.1): **monotone fall.**
4. **REM from 10 to 40 minutes** (Computation 2.1): **monotone rise.**
5. **half leaves deep 0.842391** (Computation 3.1): **nearly all of it.**
6. **half leaves REM 0.300000** (Computation 3.1): **most of it gone.**
7. **a ratio of 4.441379** (Observation 3.2): **uneven.**
8. **three quarters gives deep 0.964674** (Computation 3.1): **already enough.**
9. **three quarters gives REM 0.610000** (Computation 3.1): **not yet enough.**
10. **cycle or division** (Observation 4.1): **the separator; Paper 684.**

Closing: **“Sleep runs in ninety-minute cycles” is true, and says nothing.The length is constant while the contents exchange places: 0.760870 of the deep sleep falls in the first two cycles and 0.600000 of the REM in the last two——what repeats is only the length; the content never repeats once.So cutting the night in half leaves 0.842391 of the deep sleep and only 0.300000 of the REM, a ratio of 4.441379 in what is lost.After three quarters of the night deep sleep has reached 0.964674 while REM stands at 0.610000——the same “another hour and a half” is nearly meaningless for one and worth 0.390000 to the other.The separator is whether one looks at the cycle or at the division within it.Placed among the earlier papers——in Paper 684 the value of the period changed with the counting; here the value is settled and the contents exchange places.To be honest——physiology and health effects are not treated, and every fraction is representative.**

References

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